SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor. Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

ROBERT HENRY THURSTON.

ON October 25, 1903, Robert H. Thurston, director of the Sibley College of Cornell University and one of the editors of this JOURNAL, was stricken down with heart failure while awaiting in his library the coming of a few friends who had been invited to a dinner celebrating his sixty-fourth birthday. The news of his sudden death came as a great shock to the engineering profession throughout the United States, while to Cornell University the loss is one that seems irreparable for several years to come.

Robert H. Thurston was born in Providence, R. I., and was graduated from the engineering course of Brown University in 1859 with the degree of C.E. In 1861 he became an assistant engineer in the navy and served throughout the civil war, finally being promoted to the position of chief engineer of one of the monitors. In 1865 he was appointed an instructor in the U. S. Naval Academy at Annapolis, leaving that position in 1871 to accept the professorship of mechanical engineering in the Stevens Institute of Technology. This chair he held until 1885 when he was called to the directorship of the Sibley College of Mechanic Arts, a position which he filled until the day of his death.

The work of Professor Thurston at Stevens Institute and at Cornell University was most successful, it being characterized by great energy and executive ability,

by clear ideas of the needs of engineering education and by well-formed and definite plans for increasing its efficiency. When he took charge of Sibley College it had but sixty students, while now it has nearly a thousand, this being probably a larger registration of students pursuing mechanical and electrical courses than that of any other institution in the United States. Dr. Thurston's capacity for organization, his knowledge of all the details of the courses of study, his skill in managing the many professors and instructors under his charge and his untiring energy in work have always been an inspiring example to professors of engineering everywhere.

In 1873 Dr. Thurston was U. S. Commissioner to the Vienna exposition and wrote the volume on machinery. In 1875 he was appointed a member of the U. S. board to test metals, and became its most active member during the three years of its existence. In connection with this work he devised a machine for torsional tests and made numerous investigations in the mechanics of materials, the most important one being that which established the fact that the elastic strength of wrought iron or steel is increased by stressing the material beyond that limit. In 1883 he published a work in three volumes entitled 'The Materials of Engineering,' which has been of much value to the engineering profession; an abridged edition of this work called 'Materials of Construction' has been widely used as a text-book in technical schools.

While at Stevens Institute Dr. Thurston instituted tests of the efficiency of boilers and engines and continued these studies throughout his life, becoming one of the highest American authorities on thermodynamics. His books entitled 'Handbook of Engine and Boiler Trials,' 'Stationary Steam Engines' and 'Boiler Explosions' have had a wide circulation, while his 'Manual of the Steam Engine,' a work in three volumes, has had the high honor of having appeared at Paris in a French translation. He also made many experiments on the friction of machinery, the results of which are given in his books 'Friction and Lubrication' and 'Friction and Lost Work.' Other books which appeared from his ready pen were 'The Animal as a Machine and Prime Motor' and 'Life of Robert Fulton,' while his contributions to scientific and engineering periodicals are numbered by the hundreds.

Professor Thurston was a member of many scientific and engineering societies, both American and foreign, and always maintained an active interest in their work. In 1880 he was one of the founders of the American Society of Mechanical Engineers and its first president, and his counsel has always been highly valued by the governing board of this society. The presidency of many other societies was often urged upon him by his friends, but he seemed to have a marked aversion to being regarded as a candidate, although always ready to assist in the scientific or professional work of such organizations.

The connection of Professor Thurston with the American Association for the Advancement of Science began with his election in 1874, and in the following year he was made a fellow. In 1877 and 1878 he was vice-president of Section A, which at that time included mathematics, physics and chemistry, while the remaining work of the association was grouped as natural history in Section B. In 1884, when the association had expanded to six sections, Professor Thurston was vice-president of Section D which includes mechanical science and engineering, and he always took a deep interest in its work.

When Science began its new series in 1895, an editorial committee was organized

covering essentially the same departments as those of the sections of the American association, and Professor Thurston accepted the charge of the department of engineering. His contributions to the pages of this JOURNAL have been many and are well known to our readers. His work, which never flagged, continued to the last, for on the day of his death an article signed R. H. T. was in type and it appeared in the issue which contained the obituary announcement.

It is yet too early to speak with accurate judgment regarding the final value of the scientific and engineering work of Professor Thurston. There can be no doubt, however, that it was of great benefit to mankind, for he made engineers better scientists, promoted engineering education, helped to put engineering upon a higher professional plane, and constantly was on the watch to dispel the fogs of prejudice by help of the truths of science. His alma mater conferred upon him the degree of LL.D., and Stevens Institute devised the degree of doctor of engineering to do him special honor. In personal disposition he was quiet and retiring, but yet affable and kindly. His work was done with method and precision, and he was always most untiring to serve the interests of the educational institution with which he was connected. It is announced that the authorities of Cornell University propose to commemorate his services by the erection of a costly laboratory as a memorial, the same to be called Thurston Hall.

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*SIMULTANEOUS SOLAR AND TERRESTRIAL CHANGES.**

THERE are very many cases recorded in the history of science in which we find that the most valuable and important applications have arisen from the study of the ideally useless. Long period weather forecasting, which at last seems to be coming into the region of practical politics as a result of the observation of solar changes, is another example of this sequence.

The first indications of these changes on the sun, to which I have referred, are matters of very ancient history, and so also is the origin of some of the branches of observation on which the study of them depends.

I will begin by referring to these and to the conclusions arrived at in relation to simultaneous solar and terrestrial changes previously to the last 25 years.

The facts that there are sometimes spots on the sun, and that there is a magnetic force which acts upon a needle, seem to have been known to the ancient Chinese. In more modern times the enquiries with which we are now concerned, date from the times of Galileo (1564–1642) and Kepler (1571–1630).

To Galileo, Fabricius and Scheiner we owe the first telescopic observations of the spots on the sun; to Kepler, the basis of spectrum analysis, which has not only revealed to us the chemistry of the sun and of its spots, but enables us to study daily other phenomena, the solar prominences, which will in all probability turn out to be more important for practical purposes than the spots themselves.

It is only quite recently that the importance of the study of the prominences in this direction has been indicated, so that we have to deal, in the first instance, with a long period of years in which only the spots and their terrestrial echoes were in question.

According to Professor Wolf (as quoted by Professor Köppen), Riccioli, in 1651, shortly after the first discovery of sun spots, surmised that some coincidence

* Report, International Committee, Southport, 1903.

might exist between them and terrestrial weather changes.*

In the first year of the last century, Sir Wm. Herschel drew attention to this subject.† He wrote:

> The first thing which appears from astronomical observations of the sun is that the periods of the disappearance of spots on the sun are of much greater duration than those of their appearance.
>
> With regard to the contemporary severity and mildness of the seasons, it will hardly be necessary to remark that nothing decisive can be obtained. An indirect source of information, however, is opened to us by applying to the influence of sunbeams on the vegetation of wheat in this country. I do not mean to say that this is a real criterion of the quantity of light and heat emitted by the sun, much less will the price of this article completely represent the scarcity or abundance of the absolute produce of the country.
>
> On reviewing the period 1650–1713, it seems probable, from the prevailing price of wheat, that some temporary scarcity or defect of vegetation has generally taken place when the sun has been *without* those appearances which we surmise to be symptoms of a copious emission of light and heat.
>
> To those acquainted with agriculture who may remark that wheat is well-known to grow in climates much colder than ours, and that a proper distribution of rain and dry weather are probably of much greater consequence than the absolute quantity of light and heat derived from the sun, I shall only suggest that those very circumstances of proper alternations of rain and dry weather and wind, etc., favorable to vegetation, may possibly depend on a certain quantity of sunbeams being supplied to them.

Herschel's suggestion was a daring one, for however perfect our national statistics may have been in relation to the price of wheat, there was nowhere kept up a continuous record of the changes observable on the sun's surface, nor had there been any serious attempt made to determine the law underlying them.

In 1825 this serious attempt was made, and by Schwabe of Dessau, who discovered a cycle of about eleven years in the solar changes. Wolf afterwards took up the question.

Herschell had associated the variation in the number of spots with that in the price of corn, the connecting link being sunshine or weather. It was to him a question of meteorology.

A year after the publication of Herschel's papers, Wollaston extended the early spectrum work of Kepler and Newton by discovering that in the solar spectrum there were many dark lines; these were for the first time mapped by Fraunhofer in 1814.

Soon after 1850 it became a question of the connection of sun spots with terrestrial magnetism as well as with meteorology. A new idea was introduced.

Lamont, Sabine and Allan Broun discovered that there was a well marked coincidence between the variations of magnetic effects, as observed on the surface of our planet by delicately suspended magnets, and the quantity of spotted area observed on the sun. This in later telegraphic days is not merely a pious opinion which does not interest anybody, because, when the magnetic changes are very considerable and the disturbances arrive at a maximum, it is very difficult to get a telegram from London to Brighton.

The period around the year 1860 was rendered ever memorable by a still further extension of Kepler's and Newton's work, which at once explained the dark lines observed in the solar spectrum by Wollaston and Fraunhofer.

Hitherto undreamt-of attacks on the nature of the sun became possible. The names of Kirchhoff, Bunsen, Angström, Stokes, Balfour Stewart will go for very long down the stream of time, because they showed us that in spectrum analysis we had the power of practically conversing, chemically, with the distant worlds in

* Blandford, Bengal, *Asiat. Soc. Journ.* 65; Part II., 1875, p. 22.

† *Phil. Trans.*, 1801, p. 265.

space, and these distant worlds, of course, included the sun, although it is practically our neighbor.

It was now established that the solar radiation came from the incandescence of metallic vapors and gases in the sun's atmosphere, the metals and gases being for the most part those with which we are familiar on the earth. Not only was a high temperature demonstrated in this way, but it was further shown that above the sun's apparent surface there was an absorbing atmosphere, consisting of vapors cooler than those below, but yet hot enough to be composed of the steam of iron and other metals.

In 1865, De la Rue, Stewart and others, in an attempt to get the periodicity of the solar phenomena still more accurately determined, started work at Kew; while the former observations were carried on by Schwabe and Wolf by the eye, photography, which was then being introduced into astronomical work by the labors of Warren De la Rue, was for the first time now utilized, and a picture of the sun was taken each day.

In 1866 a new method of observing solar changes, which consisted in throwing an image of the sun on the slit plate of a spectroscope, revealed the fact that the spectra of spots differed from that of the photosphere generally; certain lines were widened in the spot spectrum.*

In 1867 a connection between changes in spotted area and in terrestrial temperatures was pointed out by Baxendell.† He noticed a distinct and very striking relation between the number of sun spots and the ratio which exists between the difference of the mean maximum temperature of solar radiation and the mean maximum air temperature on the one hand, and that of the mean temperature of the air and of evaporation on the other.

In 1868 a spectroscopic method was discovered of observing in full daylight the 'prominences' or 'red flames' which hitherto had only been glimpsed during eclipses, and it was established that, closely surrounding the sun ordinarily seen, there was an envelope, named the chromosphere, of incandescent gases and vapors, hydrogen and a new substance named helium chief among them.*

Many spectroscopic observations made on the spots and prominences about this time indicated great changes in the solar temperature in different regions, and possibly, therefore, changes in the amount of heat radiated earthwards. From the changes thus actually seen it was easy to imagine that there might be a cycle of terrestrial changes depending no longer on the sun's presentation to us in its daily and yearly rounds, but on physical changes in the sun itself, requiring, perhaps, many years to accomplish.

In 1869, Janssen showed† that by a special arrangement of the spectroscope an image of the sun, showing the prominences both on the disc and surrounding it, might be obtained.

It was not very long before it was found that the reaction of these solar changes on the earth was not so limited as had formerly been thought. This was an idea started by Dr. Stone of the Royal Observatory at the Cape of Good Hope, Piazzi Smyth of the Royal Observatory of Edinburgh, and others, about the years 1870 and 1871, but the most striking imperial contribution to the matter we owe to the labors of a distinguished meteorologist, Dr. Meldrum, director of the observatory at Mauritius, which has since become the Royal Alfred

* Lockyer, *Proc. Roy. Soc.*, October 11, 1866.

† *Memoirs of the Manchester Lit. and Phil. Soc.*, Third Series, Vol. IV., pp. 128 et seq.

* Lockyer, *Proc. Roy. Soc.*, October 20, 1868.

† *Comptes Rendus*, Vol. LXVIII. (1869), pp. 367 et seq.

Observatory. He showed that the number of wrecks which came into the harbor of the Mauritius and the number of cyclones observed in the Indian Ocean could enable any one to determine the number of spots that were on the sun about the time. The Mauritius is most admirably suited for the making of these observations, because the Tropics are really the right region in which to try and estimate the possibilities of this solar action. Meldrum found, in fact, that the maximum number of cyclones was associated with the maximum number of sun spots. He wrote:*

> During the period 1847–72 it is found that some years have been remarkable for a frequency, and others for a comparative absence of cyclones.
> 1847–51 were characterized by cyclone frequency.
> 1852–57 were characterized by comparative calm.
> 1858–63 were characterized by cyclone frequency.
> 1864–68 were characterized by decrease.
> 1868–72 were characterized by great increase.
>
> It will be seen that the years correspond with the maxima and minima epochs of sun spots. It appears to me that there is more than a mere coincidence as to time.
>
> The numbers of wrecks during these periods also show a similarly regulated frequency.

Poey, investigating shortly afterwards the cyclone condition in the West Indies,† found that the greater number of years of maxima of storms fall from six months to two years, at the most, after the years of maxima of solar spots.

Out of twelve maxima of storms, ten coincide with maxima periods of spots. Out of five minima of storms, five coincide with minima of spots.

It will be seen that the results from both the East and West Indies are the same. Next came the question of a rainfall cycle corresponding to the solar spots.‡

When I was preparing to go to India, in 1871, to observe the eclipse, Mr. Ferguson, the editor of the *Ceylon Observer*, who happened to be in London, informed me that everybody in Ceylon recognized a cycle of about thirteen years or so, in the intensity of the monsoon—that the rainfall and cloudy weather were more intense every thirteen years or so. This, of course, set one, interested in solar matters, thinking, and I said to him: "But are you sure the cycle recurs every thirteen years, are you sure it is not every eleven years?" adding, as my reason, that the sun spot period was one of eleven years or thereabouts, and that in the regular weather of the Tropics, if anywhere, this should come out.

It afterwards turned out that the period in Ceylon was really of eleven years, five or six years dry, and five or six years wet, and that a longer period of about thirty-three years was recognized.

Mr. Meldrum passed from cyclones to rainfall by a very obvious step, because cyclones are generally accompanied by torrential rains. A study of the rainfalls of Port Louis, Brisbane and Adelaide led him to the conclusion that a case had been made out for a supposed periodicity.

On my return from India I looked up the Cape and Madras records for the periods available, and found that they followed suit, hence I quite agreed with Dr. Meldrum that investigations were desirable, and I wrote as follows:*

> Surely in meteorology, as in astronomy, the thing to hunt down is a cycle, and if that is not to be found in the temperate zone, then go to frigid zones, or the torrid zones and look for it, and if found, then above all things, and in whatever manner, lay hold of, study it, record it, and see what it means. If there is no cycle, then despair for a time if you will, but yet plant firmly your science on a physical basis, as Dr. Balfour Stewart long ago suggested, before, to the infinite detriment of English science, he left the Meteorological Observatory at Kew; and having got such a basis as this, wait for results. In the absence of these methods, statements of what is happening to a blackened bulb in vacuo, or its

* *Nature*, Vol. VI., p. 357, 1872.

† *Comptes Rendus*, November 24, 1873, p. 1222.

‡ 'Solar Physics' (Lockyer, 1874), p. 425.

* 'Solar Physics, pp. 424–5.

companion exposed to the sky, is, for research purposes, work of the tenth order of importance.

With reference chiefly to Dr. Meldrum's paper, I added:

Surely here is evidence enough, evidence which should no longer allow us to deceive ourselves as to the present state of meteorology. A most important cycle has been discovered, analogous in most respects to the Saros discovered by the astronomers of old, indeed, in more respects than one, may the eleven yearly period be called the Saros of meteorology, and as the astronomers of old were profoundly ignorant of the true cause of the Saros period, so the meteorologists of the present day are profoundly ignorant of the true nature of the connection between the sun and the earth.

What, therefore, is necessary in order to discover the true nature of this nexus? Two things are necessary, and they are these. In the first place, we must obtain an accurate knowledge of the currents of the sun, and secondly, we must obtain an accurate knowledge of the currents of the earth. The former of these demands the united efforts of photography and spectrum analysis, and the second of these demands the pursuit of meteorology as a physical science, and not as a mere collection of weather statistics. When these demands are met—and in spite of the Mrs. Partingtons who are endeavoring to prevent this, they will soon be met—we shall have a science of meteorology placed on a firm basis—the meteorology of the future.*

At this time the Indian authorities were quite alive to the importance of such investigations as these. India is in the tropics, India is a child of the sun, the inhabitants depend almost entirely upon the beneficent rains which seemed, in some way or another, to depend upon solar action. India also had then the germs of one of the best equipped meteorological organizations which exist on the surface of the planet, and the meteorologists felt that there was something behind their meteorological registers which might be assisted by taking a very official step and going to headquarters, headquarters being the sun. When I was in India, in 1872, Lord Mayo, the then Viceroy, did me the honor to ask me to go to Simla with a view of choosing a site for a proposed Solar Physics Observatory. That is thirty years ago! Unfortunately, I was secretary of the Duke of Devonshire's Commission, which was then sitting, and I could not get leave, and, therefore, could not go; the scheme, which was then before the Indian authorities—which, if I may say so, was altogether grandiose and extravagant—fell through.

In 1873, the idea of the possible connection of solar and magnetic changes had got so far that the magnetic and meteorological department of the Royal Observatory at Greenwich, which had been established in 1838, received an important addition. A photo-heliograph was set up in order to continue the daily photographic record of the sun's surface, begun at Kew in 1865.

In the same year Köppen found that the maximum temperature occurs in the years of sun spot minima and the reverse, years with many spots are cool years.*

Of special importance for the connection between the temperature on the earth's surface with the sun's spotted area is the fact that the temperature curve (mean number for the whole earth) and the curve representing the sun-spotted area is identical in all the irregularities.

In the tropics in the

Year before the sun spot *Min.*, the temperature is 0.41° higher than the mean.

Year before the sun spot *Max.*, the temperature is 0.32° lower than the mean.

The variation is thus 0.73°.

* I very much regret that, in the article quoted, my reference to Carlyle's German 'Dry as dust,' as a patient enquirer who would eventually apportion credit to all meteorological workers, has been misunderstood by some of my German friends. Relying on imperfect dictionaries, which have told them that a mere 'bookworm' was meant, they have missed the high compliment I intended to pay them.

* W. Köppen, 'Uber mehrjährige Perioden der Witterung,' *Zeitschrift f. Meteorologie*, Bd. VIII., 1873, pp. 241–248 and 257–268.

By this time spectroscopic observations of the solar changes had proved that the sun was hottest when there were most spots, thereby upsetting the old idea that the spots acted as screens and reduced the radiation at sun-spot maximum. Köppen's result, therefore, was a paradox, and was thus explained by Blanford.*

> The temperatures dealt with by Professor Köppen are of course those of the lowest stratum of the atmosphere at land stations, and must be determined *not by the quantity of heat that falls on the exterior of the planet, but on that which penetrates to the earth's surface, chiefly to the land surface of the globe.* The greater part of the earth's surface being, however, one of water, the principal immediate effect of the increased heat must be the increase of evaporation, and therefore, as a subsequent process, the cloud and the rainfall. Now a cloudy atmosphere intercepts the greater part of the solar heat, and the re-evaporation of the fallen rain lowers the temperature of the surface from which it evaporates and that of the stratum of air in contact with it. The heat liberated by cloud condensation doubtless raises the temperature of the air at the altitude of the cloudy stratum; but at the same time we have two causes at work, equally tending to depress that of the lowest stratum. As a consequence, an increased formation of vapor, and therefore of rain, following on an increase of radiation, might be expected to coincide with a low air-temperature on the surface of the land.†

The next important advance had to do with atmospheric pressure. In 1875, Mr. C. Chambers, the director of the Bombay Observatory, found that

> The variation of the yearly mean barometric pressure at Bombay shows a periodicity nearly corresponding in duration with the decennial sun-spot period.‡

The years round 1875 were rendered very important by the number of new organizations established to record and demonstrate various classes of observations with which we are concerned in this short history. Meteorological enquiries on a large scale were organized at home and in India, and observatories were established at Potsdam, Paris and London, with the main object of studying solar changes. At the same time steps were taken to resume observations in the tropics. It is not out of place here to make a brief reference to what was done in Britain and India.

The government took this action in consequence of a strong recommendation of the Royal Commission on Science, presided over by the late Duke of Devonshire, of the establishment by the state of an Observatory of Solar Physics in which enquiries relating to the nature of the sun and its changes should be fostered and various investigations which were necessary should be carried on.

The commission also proposed that similar institutions should be established in various parts of the empire.

The ground on which the Royal Commission, and subsequently a memorial presented to the government by the British Association, urged this new departure was that, in the opinion of a considerable number of scientific men, there was a more or less intimate connection between the state of the sun's surface and the meteorology of the earth; and they called attention to the fact that recent independent investigations on the part of several persons had led them to the conclusion that there was a similarity between the sun-spot period, periods of famine in India, and cyclones in the Indian Ocean. The memorialists concluded by saying:

> We remind your lordships that this important and practical scientific question can not be set definitely at rest without the aid of some such institution as that the establishment of which we now urge.

The Lords of the Committee of Council on Education referred this memorial to a

* Blanford, Bengal, *Asiat. Soc. Journ.*, 1875.

† See also Blanford, *Nature*, April 23, 1891, Vol. 43, p. 583.

‡ 'Meteorology,' Bombay Presidency, August, 1875, S. 26, p. 12.

committee, consisting of Professor Stokes, Professor Balfour Stewart and General Strachey, for their opinion as to whether a commencement might not be made to give effect to the proposals of the memorialists by utilizing the chemical and physical laboratories at South Kensington, as the proposed observatory must be more chemical and physical than astronomical. The following paragraph appeared in the terms of reference:

> Although we are not at present in a position to consider the establishment of a physical observatory on a comprehensive scale, we believe that some advantage can be gained if a new class of observations can be made with the means at command, since the best method of conducting a physical observatory may thus be worked out experimentally, and an outlay eventually avoided which, without such experience, might have been considered necessary.

While the discussion as to the establishment of a solar physics observatory in this country was going on, Lord Salisbury, who was then Secretary of State for India, permitted me to send him a memorandum on this subject. In it I pointed out that what we wanted, especially in reference to solar enquiries, was to learn, day by day, what the sun was really doing, which India and other tropical countries always could tell us, while it seemed almost impossible that we should ever get sufficiently continuous records in England.

I gave the following extracts:

> Solar research is now being specially carried on in Europe at—
>
> 1. Potsdam, in the new Sonnenwarte.
> 2. Paris, in the new physical observatory.
> 3. Rome and Palermo.
> 4. South Kensington, in connection with the Science and Art Department.
> 5. At Greenwich, Wilna, and other places it is carried on in a less special way.
>
> In these European observatories, however, especially in the more northern ones, we are attempting to make bricks without straw, that is, the climate is such that the observations are often interrupted, at times for weeks together, while, in addition to this, in winter the sun's altitude is so small that fine work is impossible.
>
> While this state of things holds in Europe, in India, on the other hand, one has an unlimited and constant supply of the *raw material*, by which I mean that here one can, if one chooses, obtain observations of the finest quality in sufficient quantity all the year round. I may even go further, and say that, limiting my remark to English ground, we have in India a *monopoly* of the raw material.

The prayer of the memorandum was granted, and shortly afterwards I had the pleasure of sending out one of my assistants to India. Unfortunately, he died soon after the first series of daily photographs of the sun had been commenced, but eventually the Trigonometrical Survey Department took the matter up, an observatory was built at Dehra Dun, and India began its work, and I am thankful to say that it has gone on continuously ever since.

It was not till 1879, and after a letter from the Duke of Devonshire, that a sum of £500 was taken on the estimates to replace the assistance formerly obtained by myself from the Government Grant Fund administered by the Royal Society, and to allow of more research work being undertaken. At the same time, the Solar Physics Committee was appointed. The object sought was to make trial of methods of observation, to collect and discuss results, to bring together all existing information on the subject, and to endeavor to obtain complete series of observations along the most important lines.

This state action was taken because the sun has to be studied, if studied at all, continuously, because it is ever changing, and the more we study it the longer are the cycles which we find to be involved; hence, all enquiries into its nature must be on an imperial basis. Individuals die, nations remain. Nor is this all. Observatories are not only wanted in the centers of intellectual activity where research can be conducted in a scientific atmosphere, but

there must be others to obtain the necessary observations in those favored regions of our planet in which the maximum of sunshine can be depended upon.

The then astronomer royal, Sir George Airy, was most sympathetic, and as a result of this state action, the little observatory at South Kensington was shortly afterwards enlarged; it has considerably grown since then, but it is still in the experimental stage. Although, perhaps, I am not the one to say it, I am prepared to take the responsibility of stating that it is now one of the best equipped for its special work in the world. It certainly is the shabbiest to look at. Irreverent comparisons have been made even in the House of Commons; the general appearance of its wood and canvas huts having been likened to that of a more or less disreputable looking traveling menagerie, but, at all events, it is instrumentally efficient, and that for the present must be sufficient.

During the last quarter of a century a great deal of work has been going on, and the colonies and dependencies of Britain have also been doing yeoman service; very little has been said about it, because not all departments are in the habit of advertising themselves, and Blue Books are not as a rule light reading. In the first place, the Indian daily photographic record, which was weak during a month or two during the S.W. monsoon, was supplemented by the erection of a duplicate instrument at the Mauritius; and I am again thankful to say that the work has gone on at the Mauritius continuously since. Thus we have now two tropical records, which, taken together, may be described as absolutely continuous, of solar changes sent to us in the most imperial fashion by two observatories. Another appeal was made to Australia. For a time records were sent us, but I am sorry to say that after a time they ceased.

These records are sent regularly with every precaution against loss, to the observatory at South Kensington; and for the days when no photographs have been taken at Greenwich the necessary photographs are transmitted there, where they are reduced in continuation of the record commenced in 1873 there, in succession to Kew.

What has been the result of this? The late astronomer royal took up this work at Greenwich in 1873. In 1874, 1875, 1876, 1877, 1878, the average number of days on which it was possible to obtain photographs in each year was a little over 160, the exact figures being 159, 161, 167, 171, 149. This was Greenwich working alone, national work.

Next, we come to the imperial work. Selecting years at random, and dealing with 1889 to 1893, I find that we obtained photographs of the sun in 1889 for every day in the year except five, in 1890, for every day except four, in 1891, for every day except two. It is easy to understand that with such a magnificently complete record as this the study of solar physics was enormously improved.

Very fortunately for science, even before these steps were being taken to secure a continuous record of the spotted area, Professor Respighi (1869) and Professor Tacchini (1872) had commenced at Rome a daily record of the solar prominences and of the latitudes at which they appeared at different times.

I pass on to some of the most important work done during the last quarter of a century, only referring to the results obtained which bear upon the connection between solar and terrestrial changes.

Many important advances were made in 1878.

Mr. F. Chambers, in continuing his studies on the Indian barometer, found* a remarkable degree of resemblance in the progression of barometric pressure during

* *Nature*, Vol. XVIII., p. 567.

summer, winter and year, and sun spots from year to year; but he noticed that the barometric curve *lags* behind the sun-spot curve, particularly in the years of maxima of sun spots. The winter curve is more regular than the summer one, probably because the weather generally in India is more settled in the winter than in the summer; but on the whole the two curves support each other in having a *low pressure* about the time of *sun-spot maximum*, and a high pressure about the time of sun-spot minimum. We may, therefore, conclude that the *sun is hottest* about the time when the *spots are at a maximum*. He added, that these results appear to harmonize well with the decennial variations of the rainfall in India, and to throw light upon the inverse variation (compared with the sun spots) of the winter rainfall of northern India.

Dr. Allan Broun also, in a discussion of Indian barometric readings, found that the years of greatest and least pressure are probably the same for all India, and that, therefore, the relation established by Mr. Chambers for Bombay holds for all India.*

I next pass to rainfall. Dr. Meldrum, returning to his rainfall studies, found that†

> There is a remarkable coincidence between the rainfall and sun-spot variation at Edinburgh, much more remarkable than that at Madras. The years of maximum and minimum rainfall, and sun spots for the mean cycles, coincide, and on the whole there is a regular gradation from minimum to maximum, and from maximum to the next minimum.

The minimum rainfall occurred, on an average, in the year immediately preceding the year of maximum sun spots.

The results of these investigations show that the rainfall of 54 stations in Great Britain from 1824–1867 was .75 inches *below mean* when sun spots were at a minimum, and .90 inches *above mean* when sun spots were at a maximum.

For the 34 stations in America, the corresponding numbers were .94 inch in 1.13 inches.

In the report of the Meteorological Department of the government of India, published this year (1878), the following reference to solar action occurs:

> The following are the main important inferences that the meteorology of India in the years 1877–1878 appears to suggest, if not to establish:
>
> There is a tendency at the minimum sun-spot periods to prolonged excessive pressure over India, and to an unusual development of the winter rains, and to the occurrence of abnormally heavy snowfall over the Himalayan region. * * * This appears also to be accompanied by a weak southwest monsoon.

In 1880 the relation of India famines and the barometer was first fully treated by Mr. F. Chambers, the meteorological reporter for western India.* He concluded from his enquiry that there is some intimate relation between the variations of *sun spots, barometric pressure* and *rainfall;* and as famines in general are induced by a deficiency of rain, it is probable that they also may be added to the above list of connected phenomena.

Commencing with the daily abnormal variations observed at several stations in western India, it was found that as the time over which an abnormal barometric fluctuation extended became longer and longer, the range of the fluctuation became more and more uniform at the various stations, thus leading to the conclusion that the '*abnormal variations of long duration affect a very wide area.*' For testing this, the conditions of Batavia were compared with those at Bombay, and the results showed a striking coincidence, the curves obtained for the two places being almost identical in form, but with this remarkable difference: the curve for Batavia was

* *Nature*, Vol. XIX., p. 6.

† *Nature*, Vol. XVIII., p. 565.

* *Nature*, Vol. XXIII., p. 109.

found *to lag* very persistently about one month *behind* the Bombay curve.

Similar results were then worked out for other stations. St. Helena, Mauritius, Madras, Calcutta and Zi-ka-wei. On comparing the curves obtained for these various places, though a strong resemblance in form betwen all the curves is observed, there is also strong evidence of a want of simultaneity in the barometric movements at different stations, and that as a rule the changes take place at the *more westerly stations* several months *earlier than* at the more *easterly ones.*

Thus, on comparing the curves for St. Helena and Madras from 1841–1846, the latter sometimes lagged behind the former as much as six months, and for Bombay and Calcutta the corresponding difference was often upwards of six months.

The facts suggested to him long atmospheric waves (if such they may be called) traveling at a very slow and variable rate round the earth, from *west to east*, like the cyclones of the extra-tropical latitudes.

With special reference to famines, he remarked that, on comparing the dates of all the severe famines which have occurred in India since 1841, widespread and severe famines are generally accompanied or immediately preceded by waves of high barometric pressure. He suggested, therefore, that intimation of the approach of famines might be obtained in two ways:

(*a*) By regular observations of the solar spotted area, and early reductions of the observations, so as to obtain early information of current changes going on in the sun.

(*b*) By barometric observations at stations differing widely in longitude, and the early communications of the results to stations situated to the eastward.

In the same year, Dr. H. F. Blandford discovered that*:

Between Russia and Western Siberia on the one hand, and the Indo-Malayan region on the other, there is a reciprocating and cyclical oscillation of barometric pressure, of such a character that the pressure is at a maximum in *Western Siberia* and *Russia* about the epoch of maximum sun-spots, and in the *Indo-Malayan* area at that of minimum sun-spots.

Up to 1881, the general idea had been that there was a great difference between the meteorological conditions at the maximum and minimum of the sun-spot curve, but the more numerous and more accurate series of observations available in the year in question revealed to Meldrum 'extreme oscillations of weather changes in different places at the turning points of the curves representing the increase and decrease of solar activity.'

This was a most important change of front. Not the maximum only, but both the maximum and minimum had to be considered.*

In relation to these pressure changes he wrote as follows:†

Among the best established variations in terrestrial meteorology which conform to the sun-spot cycle, are those of tropical cyclones, and the general rainfall of the globe, both of which imply a corresponding variation in evaporation and the condensation of vapor. Now the variation of pressure with which we have to deal evidently has its seat in the higher (probably the cloud-forming) strata of the atmosphere. This is not only illustrated in the present instance by the observed relative excess of pressure at the hill stations as compared with the plains, but also follows as a general law from the fact established by Gautier and Köppen, viz., that the temperature of the lowest stratum varies in a manner antagonistic to the observed variation of pressure. It is then a reasonable inference that the principal agency in producing the observed reduction of pressure at the epoch of sun-spot maximum is the more copious production and ascent of vapor, which may operate in three different ways. First, by displacing air the density of which is three eighths greater; second, by evolving latent heat in its condensation; and thirdly, by causing ascend-

* *Nature*, Vol. XXI., p. 480.

* 'Relations of Weather and Mortality, and in the Climatic Effect of Forests.'

† *Nature*, XXI., p. 482.

ing currents, and thus reducing dynamically the pressure of the atmosphere as a whole. The first and second of these processes do not indeed directly reduce the pressure but only the density of the air stratum while they increase its volume. In order, therefore, that the observed effect may follow, a portion of the higher atmosphere must be removed, and this will necessarily flow away to regions where the production of vapor is at a minimum, viz., the polar and cooler portions of the temperature zones, and more especially those where a cold dry land surface radiates rapidly under a winter sky. Such an expanse is the great northern plain of European Russia and Western Siberia north of the Altai.

In 1886 we got the first fruits of the observations of the widened lines in sun spots, which had been obtained on a definite plan, since 1879. The changes which occurred from a spot-minimum to a spot-maximum, and some distance beyond, had therefore been recorded. The changes were most marked, showing a great change in the chemistry of the spots at these times. At minimum the lines chiefly widened were those of iron and some other metals, but at the maximum the lines widened were classed as 'unknown,' because they had not been recorded in the spectra of the terrestrial elements. It was reasonable to suppose, therefore, that the sun was not only hotter at maximum, but hot enough to dissociate iron vapors.*

In 1891 Janssen's suggestion of 1869 was brought into a practical shape for observatory work, by Hale and Deslandres,† and the prominences on the sun's disc, and surrounding it, were photographed in full daylight by using only the light radiated by the calcium vapor, which they always contain.

By the year 1900 we had accumulated, at South Kensington, observations of the widened lines for a period of over 20 years. There was a curious break in the regularity of the results obtained after 1894, and the Indian meteorologists reported contemporaneous irregularities in the Indian rainfall.

I determined, therefore, to make a connected enquiry into both these classes of phenomena. Thanks to the establishment of the Indian Meteorological Department in 1875 we had rainfall tables extending over a quarter of a century, and in the tropics, where the problems might be taken as of the simplest, to compare with the new solar data.

I have already stated that in the preliminary discussion of the most widened lines observed in the sun spots up to the year 1885, a most remarkable difference was observed in the lines observed at sun-spot maximum and minimum. This continued till about 1895, another ten years. As the curve of iron lines went up, the curve of 'unknown' lines came down; there were therefore *crossings* of the curves which might, on the hypothesis before referred to, be taken as the times at which the temperature of the solar system had a mean value. These crossings turned out to be about half-way between the maxima and minima of the spotted area which had to be considered as the times at which the sun was hotter and colder than the mean.

We were then brought into the presence of three well-marked stages of solar temperature—it was no longer a question merely of spots and no spots, but of heat pulses.

The next point was to study these heat pulses in relation to the Indian rainfall, and it was found that in many parts of India the plus and minus heat pulses on the sun, which, of course, occurred immediately after the time of mean temperature, when the sun was getting either hotter or colder, were accompanied by pulses of rain in the Indian Ocean and the surrounding land. It was next found, from a study of the Indian Famine Committee's reports,

* *Proc. Royal Soc.*, 1886, p. 353.

† *Comptes Rendus*, August 17, 1891.

that the famines which have devastated India during the last half century have occurred in the intervals between the pulses.

In 1902, with a view of getting more light on the important issues raised by the comparison of the solar heat pulses and the Indian rainfall, I determined to reduce the observations of prominences made by Tacchini at the Observatory of the Collegio Romano since 1874, and compare the Indian meteorological conditions with them. The reason for this step was that the admirable photographs of the prominences on the solar disc, published by Hale and Deslandres, showed the extensive area over which they were distributed. An argument which has been used against the possible connection between solar and terrestrial changes was based upon the small area covered by spots. In 1877 Eliot wrote as follows:*

> So far as can be judged from the magnitude of the sun spots, the cyclical variation of the magnitude of the sun's face free from spots is very small compared with the surface itself; and consequently, according to mathematical principle, the effect on the elements of meteorological observations for the whole earth ought to be small.

Now the photographs, to which I have referred, exhibited broad bands of prominences extending almost across the whole disc, and if we assume two belts of prominences, N. and S., 10° wide, with their centers over latitude 16°, a sixth of the sun's hemisphere would be in a state of disturbance. Hence it followed that the prominence effect, when fully studied, might be much more striking and important than that produced by spots.

The prior work in connection with the Indian rainfall had shown not only that there was a close connection between pressure and rainfall, but that the pressure was much the more constant element over the different areas. The comparison with the prominences obtained from the discussion of Tacchini's results was in the first instance compared with the Indian pressure curve.

The result was magnificent. In addition to the well-marked prominence maximum at the maximum of the spotted area, there were others corresponding approximately with the 'crossings' of the widened lines, and all were re-echoed by the Indian barometers!

The sun-spot cycle of eleven years gave way to a prominence cycle of about 3.7 years, and by this interval, as a rule, are the Indian pressures separated.

To see whether such a striking and important result as this was limited to Indian ground, the magnificent series of pressure obtained at Cordoba in South America were studied. Here the same effect was also most marked, but with the important difference that the curves were inverted; that is, high pressure years in India were represented by low pressure years in Cordoba. In order to extend the Indian and Cordoba areas and see how far these conditions prevailed, the pressure variations of stations as widely distributed as possible were examined. The result of this inquiry showed that the world might be divided roughly into two portions. The Indian area was found to extend to Australia, East Indies, Asiatic Russia, Mauritius, Egypt, East Africa and Europe, while the Cordoba region might be said to include not only South and Central America, but the United States and Canada, extending further west than Honolulu.

This discovery of this barometric surge, which has been corroborated since by Professor Bigelow, was an important advance, and will enable the investigator to connect up regions that undergo similar pressure changes.

In addition to the two periods, namely, 11 and 3.7 years, mentioned above, Brück-

* 'Report on the Meteorology of India,' 1877, p. 2.

ner* has pointed out that there is a long period weather variation. His discussion of all the available data of pressure, rainfall, temperature, etc., led him to conclude that there is a periodical variation in the climates over the whole earth, the mean length of this period being about 35 years.

Since this work, a recent discussion of the sun-spot data by Dr. W. J. S. Lockyer† has brought to light a similar long period, and this has taught us that each eleven-year cycle is different from the one immediately preceding and that following it.

A further inquiry into the distribution of the solar prominences, as observed by Respighi, Secchi Tacchini, Ricco, and Mascari,‡ has resulted in increasing our knowledge of the circulation of the solar atmosphere. The centers of prominence action, or the centers of the prominence belts, have a tendency to move from low to high latitudes, the opposite of spots; generally speaking, two belts in each hemisphere exist for some time, then they couple up and move towards the solar poles, while in the meantime a new belt begins to form in low latitudes.§

The existence of prominences in the polar regions is coincident with great magnetic disturbances on the earth, just previous to or about the time of sun-spot maxima.‖ Further, these polar prominences are responsible for the existence of large coronal streamers near the solar poles, as seen during solar eclipses about the time of sun-spot maximum. In fact, recent research seems to indicate that this prominence circulation is intimately associated with all the different forms of the corona.*

There seems little doubt, therefore, that we must look to the study of the solar prominences not only as the primary factors in the magnetic and atmospheric changes in our sun, but as the instigators of the terrestrial variations.

In dealing with solar phenomena, especially from a meteorological point of view, it is of great importance that the solar disc be treated in zones and not as a whole.

Just as it has been shown that the prominences sometimes exist in these zones in one hemisphere at one time, so is this the case with spots, but unfortunately, it is only until very recently that the phenomena occurring in each hemisphere have been treated in this manner.

It has already been pointed out that a possible connection existed between changes in the spotted area of the sun and terrestrial temperatures. Quite recently this question has been studied by Charles Nordmann † who finds that—

> The mean terrestrial temperature exhibits a period sensibly equal to that of solar spots; the effect of spots is to diminish the mean terrestrial temperature, that is to say, that the curve which represents the variations of this is parallel to the inverse curve of the frequency of solar spots.

NORMAN LOCKYER.

SOLAR PHYSICS OBSERVATORY,
SOUTH KENSINGTON.

THE GERMAN ANTHROPOLOGICAL ASSOCIATION.

THE German Anthropological Association is just as old as the German Empire. The thirty-fourth meeting of the society, held at Worms, August 9–13, 1903, was the first to take place since the death of its most distinguished founder, the late Ru-

* 'Klimaschwankungen,' Eduard Brückner (Vienna, 1890).

† *Proc. Roy. Soc.*, Vol. 68, pp. 285–300.

‡ 'Memorie della Societa degli Spettroscopisti Italiani.'

§ *Proc. Roy. Soc.*, Vol. 71, pp. 446–452.

‖ *Ibid.*, pp. 244–250.

* *Monthly Notices R. A. S.*, Vol. LXIII., 1903.

† *Comptes Rendus*, No. 18, May 4, 1903, Vol. 136.

dolph Virchow. Professor Virchow is said not to have missed a meeting of the association since its organization until disabled by the accident which eventually ended in his death. The tribute paid to him in Professor W. Waldeyer's presidential address was, therefore, eminently fitting. Virchow helped to do for anthropology in Germany thirty-three years ago what was done for anthropology in America only last year by the founders of the American Anthropological Association. He was a potent factor in the growth of the science, as well as of the new organization, and that of both was phenomenal. Three hundred and forty-five took part in the Worms meeting. A study of the program and of the audiences at every sitting was, to me, a source of inspiration, and strengthened my faith in the future of our own association, now scarcely more than a year old. But Professor Waldeyer's address was not all tribute. He called attention to the needs of an international understanding as to methods in anthropometry, of more thorough and general university instruction in anthropology; a closer union of the various anthropological organizations of each nation, and, for Germany especially, a great central anthropological institute for purposes of both research and instruction. Berlin was suggested as a suitable location for such an institute, on account of its large and varied collections. It was also suggested that municipal and provincial museums turn over to the central institute all needed duplicates and whatever else could be spared. This is precisely what is being done in Denmark, which has gone even further and made the director of her National Museum supervisor of all the provincial museums. The director pays an annual visit to each museum. If he finds specimens that are needed toward making the national collection more complete, the smaller museum must, for a consideration, part with these, even though they be not in the nature of duplicates.

Professor Schwalbe's paper, the first on the program, was somatological: 'On a Comprehensive Investigation of the Somatic Characters of the German People.' The speaker passed in review what had been done already in this direction. All are familiar with the collection of statistics relative to the color of the skin, hair and eyes of 6,758,827 German school children. These results, due largely to Ecker and Virchow, were published in 1886. Schaaffhausen's extensive catalogue of the collections of crania in the German museums aided materially in determining the distribution of head-form in the empire. Schwalbe hopes to see done for Germany what has been done for France by Collignon and Lapouge; for Italy, by Livi; and for Sweden, by Fürst and Retzius. More has been accomplished for Spain than for Germany; and even less is known about Great Britain, Denmark, Holland and Belgium. As regards the German Empire, exception must be made of Baden and Bavaria, thanks to the labors of Ammon and Ranke, respectively.

Observations on school children alone will not suffice, and in Prussia, especially, permission to make the necessary observations on soldiers has not yet been obtained from the Ministry of War. For fifteen years Professor Schwalbe has made use of material furnished by the anatomical and pathological institutes in Strassburg. In that time he has measured 4,000 Alsatians, 1,500 of which, including both sexes, were adults. Professor Schwalbe's paper was accompanied by a table designed for use in taking measurements on corpses. The interest in his paper found immediate expression in the appointment of a commission.

Professor Rudolph Martin presented 'Some New Anthropometric Instruments,'

intended both for the laboratory and for field-work. Professor Ranke discussed 'Brain Measurements and the Horizontal Plane of the Brain'; and Dr. Birkner, 'Race Anatomy of the Soft Parts of the Face.' The latter had prepared instructive tables showing the differences between the facial type of the Chinese and that of the European. The 'Comparative Osteology of the Human Forearm,' by Dr. Fischer, was a comparison of the upper portion of the ulna in man and anthropoids, with special reference to the Neanderthal race. Drawings and tables were used in illustration. Dr. Gaup's 'The Vertebrate Skull with Demonstrations from Models,' a phylogenetic study, was especially appreciated by the anatomists present.

Dr. Tschepourkowsky, secretary of the Russian Anthropological Society, was present and read a paper: 'On the Inheritance of the Cephalic Index from the Side of the Mother.' Professor Stieda presented: 'Painted Human Bones from Southern Russia.' The coloring matter was probably applied originally to the bodies at the time of burial, and received indirectly by the bones after the flesh had disappeared. Dr. K. von den Steinen spoke of "Genealogical 'Knotenschnüre' in the South Seas." This ancient and unique mnemotechnic system is still retained by the natives, and serves them as writing and as genealogical charts.

Dr. Thilenius's paper dealt with the art of a people now practically exterminated: 'Ornamental Carvings from Agomes' (Bismarck Archipelago). An interesting collection of wood carvings, especially spatulæ employed in the betel habit, has fortunately been preserved. The series includes all gradations between the human form and various animal forms.

Of kindred interest was 'The Significance of Mat- and Tattoo-patterns among the Marshall Islanders,' by A. Krämer. These unique and beautiful patterns are successfully combined with color schemes. Tattooing is looked upon as a gift of the gods and its execution is combined with religious ceremonies. Other ethnographic themes were: 'The Value of Ethnographic Analogies,' by Dr. Ehrenreich; 'South American Weaving and Basketry,' by Dr. Max Schmidt; 'The Problems of Social Ethnology,' by Dr. Steinmetz, and 'Ethnographic Transformations in Turkestan,' by R. Karutz, who referred to the changes that have taken place with the Russification of West Turkestan.

Professor Seger was heard on a subject in which he is *facile princeps:* 'The Ruins of Yukatan.' In his paper on 'The Protection of Prehistoric Monuments,' Dr. Seger recommends: (1) The passage of a protective law; (2) the appointment of a commission for each province; (3) the creation of a special fund to be used for the purpose of purchasing monuments or sites, of carrying on research and of publishing reports; (4) the fixing of geographic boundaries within which central, provincial and local museums are to find their respective spheres of influence and activity; (5) the adoption of a uniform procedure in respect to excavations, and the general treatment of specimens. The association inaugurated the movement in line with Dr. Seger's suggestions by appointing an archeological commission.

Dr. Edmund Blind's paper, entitled 'Neolithic Inhabitants of Alsace,' fills a gap in the anthropological history of that region. According to his researches, the Neolithic race in Alsace was dolichocephalic. Not a single brachycephalic skull was found, although some were on the borderland of mesocephaly. A similar topic, 'The Races of the Stone Age,' by L. Wilser, led to a lively discussion.

Dr. Lissauer's "Scheme of Classification

for 'Radnadeln'" had already appeared in print. Dr. Schumacher's subject was: 'On Bronze Age Caches in Southwestern Germany.' For convenience or safety these caches were so located as easily to be found by the owner; often near some prominent natural feature, as a cliff or rock. They were sometimes placed in large pots or wooden chests, or wrapped in skins. Such stores include weapons, tools and ornaments of bronze; gold ornaments are rare. They make it possible to trace definite prehistoric trade routes. It has been determined, for example, that the source of supply during the early bronze age was the Danube valley, while later the imports were from northern Italy, Switzerland and France. Ancient roadways as well as mountain passes have been traced.

Dr. C. Mehlis discussed 'Burial Tumuli of the Pre-Roman Period in the Vorderpfalz,' including those of the late bronze age, Hallstatt and La Tène epochs; and Herr Welter, 'The So-called Mardellen of Lorraine,' dwelling sites belonging to the La Tène epoch. Professor H. Klaatsch's contribution, 'The Problem of the most Primitive Flint Artifacts,' aroused unusual interest. By way of demonstration, several hundred primitive implements from France, England, Belgium and Germany were displayed so as to form a geographic, as well as chronometric, series, as follows: (1) Puy Courny and Puy Boudieu, Aurillac (upper Miocene); (2) Chalk Plateau, Kent and Sussex (middle Pliocene); (3) Saint-Prest, France (upper Pliocene); (4) Britz and Rüdersdorf, Berlin; (5) Taubach; (6) Belgian Diluvium; (7) Eoliths from Chelles; (8) Vézère (Paleolithic). Professor Klaatsch had personally visited all the localities named, and had himself collected most of the specimens exhibited. He agrees with the views expressed by Rutot of Brussels, the ablest living exponent of the so-called eoliths of the Tertiary and Quaternary epochs. Many of the pieces, although not intentionally shaped, had evidently been utilized; others again were slightly altered so as to accommodate the hand, and still others showed definite series of retouches.

Dr. J. Nuesch gave the results of 'Recent Archeological Discoveries at Kesslerloch.' This important station has been known since 1874, when the north entrance was excavated. Very important discoveries have recently been made in the south entrance. These discoveries make it clear that Kesslerloch is older than Schweizersbild, another well-known station in which important finds have recently been made. From the view point of paleolithic art, Kesslerloch also stands preeminent among Swiss stations.

Nuesch has not only collected over 2,000 specimens of the paleolithic period, including wonderful pieces of sculpture and engraving, but also hearths with burnt bones of the mammoth, rhinoceros, reindeer and wild horse. Dr. Nuesch announced the further discovery of remains of a pygmy race at Kesslerloch. Those who attend the International Congress of Americanists to be held in Stuttgart next summer will have the opportunity of visiting both Kesslerloch and Schweizersbild as a part of the official program.

Worms has long been recognized as one of the chief historic cities of Germany, as well as the center of the Teutonic legendary period. Recent discoveries in the environs serve to place her in the forefront from the view point of the prehistoric also. To the researches of Dr. Koehl, chairman of the local committee, Worms is indebted for this new and proud distinction. His excavations cover a period of several years, and have to do with not only the burial places dating from various epochs of the neolithic period, but also with those of the Hallstatt, Roman and Frankish epochs. In anticipa-

tion of the meeting, he had uncovered just outside the city thirty or forty Roman and Frankish burials, as well as the remains of an ancient Roman roadway. The skeletons and funerary objects were left in their original positions until after our visit, when they were removed—the skeletons to the Berlin Museum, and all other objects to the Paulus Museum in Worms. Excavations of a similar nature had also been carried on under Dr. Koehl's direction at three other localities. Near the West-end School in Worms, we were permitted to see burials of the Hallstatt epoch; while at Monsheim and Mölsheim, a few miles to the west of Worms, neolithic burials and dwelling sites, belonging to three different epochs, were exposed to our view. Here the pottery belongs to three distinct types, as set forth in Dr. Koehl's 'Festschrift' ('Die Bandkeramik der steinzeitlichen Gräberfelder und Wohnplätze in der Umgebungen von Worms'), as follows: (1) An early geometric pottery, the so-called Hinklestein type; (2) the Spiral-meander type, and (3) a later geometric pottery or Rössener type.

The next meeting of the association will be held in Greifswald, and is to include on its program an excursion to the museums of Stockholm.

GEORGE GRANT MACCURDY.
YALE UNIVERSITY MUSEUM,
October 28, 1903.

SCIENTIFIC BOOKS.

SMALL'S FLORA OF THE SOUTHEASTERN UNITED STATES.

Two works, each of them a masterpiece in its time, have given us our principal knowledge of the plants of the Southern United States. The first, 'Elliott's Sketch of the Botany of South Carolina and Georgia,' appeared in 1821 to 1824. The second, 'Chapman's Flora of the Southern States,' was first published in 1860, and was issued also in subsequent editions with new matter in the form of appendices. All botanists will welcome Dr. John K. Small's 'Flora of the Southeastern United States,' the new masterpiece of southern botany. The book contains 1,370 pages, besides twelve pages of introductory matter, and describes 6,364 species—another illustration of the fact that we are living in a time of men who do things. It is interesting to note in this connection that the author, after giving us in these 1,382 pages the result of ten years' persistent labor, required only a modest twenty-five lines of preface to tell how he did it. The work will be especially useful to botanists in Mississippi, Louisiana, Texas and Oklahoma because those districts have been only imperfectly covered by the preceding floras, which were based chiefly on material from the South Atlantic states. The new work does not, it is true, profess to contain more than the plants east of the one hundredth meridian, but in fact we do find in it such distinctly desert types as the ocotillo, *Fouquieria splendens,* and the creosote bush, *Covillea tridentata.*

The book follows the Engler and Prantl sequence, the American Association nomenclature and the metric system of measurement. It also gives family names throughout a termination in -aceae, a practise which has already been adopted in the publications from the United States National Herbarium and which, it is believed, will meet with general approval. The name Brassicaceae, for example, is a much more orderly, suitable and significant designation for the mustard family than the name Cruciferae, and it is only the greater familiarity with the latter name which leads many botanists still to cling to it.

It has come to be generally recognized in the last two decades that the generic grouping of species would be much more convenient and significant if the looser genera, containing diverse groups of species, which had been fashionable during the preceding half century, were divided into genera each of which represented an evident genetic community. A subdivision of these loose genera has been going on for several years past in America and in Germany. In Dr. Small's new book this tendency has been carried to an extreme to

which not all of us will be prepared to follow. Most botanists will approve the generic separation of the deerberries, represented by *Vaccinium stamineum,* from the blueberries, represented by the European *Vaccinium myrtillus* and its several American relatives, and many will prefer to join him in separating *Vaccinium erythrocarpon* as a generic type under the name *Hugeria,* but it is doubtful whether many will be willing to place the white pine in the genus *Strobus,* distinct from *Pinus,* or the nut pine of Arizona in still another genus, *Caryopitys.*

The book is not wholly without evidence of ill-considered conclusions, as may be illustrated by the genus *Ribes.* Pursh in 1814 described from the garden of Fraser, the English nurseryman, a *Ribes resinosum* which was alleged to have come from the mountains of eastern North America. The plant afterward was identified by several competent botanists with *Ribes orientale,* from the mountains of Asia Minor, and was accordingly dropped from the American flora. If the author has sufficient evidence to restore the plant to good standing as a native of the Southern United States, he does not adduce it in his book. The name *Ribes gracile* Michx. has been transferred from the plant with which it has been associated for a generation and applied to a plant to which on geographic grounds it could not possibly have applied, while for the plant we formerly knew as *gracilis* Nuttall's name *missouriense* has been taken up. It is more than doubtful whether changes based on such imperfect or incorrect information are advisable.

Most botanists will be slow in becoming convinced that the southern states contain 53 species of *Sisyrinchium* or 185 species of *Crataegus,* but it must be stated that the matter in both these genera was prepared by special contributors, not by Dr. Small himself.

The admirable keys with which the book is equipped throughout, a new feature in Southern floras, will greatly facilitate its use by students. This and the other timely and authoritative qualities of the work so greatly counterbalance any faults that may be charged against it that the book will necessarily take its place as the standard work on Southern botany.

Frederick V. Coville.

Ueber die Bedeutung des Darwin'schen Selectionsprincips und Probleme der Artbildung. By Dr. Ludwig Plate. Second edition. Leipzig, W. Engelmann. 1903. 8vo. Pp. viii + 247.

The mass of literature which has grown up around the doctrine of natural selection since it was first propounded has reached the proportions of a forest, so dense that one may well shrink from the task of penetrating its depths or of keeping pace with its rapid growth. Numerous sturdy trees, well repaying a close acquaintance, occur, but they are apt to be hidden from view by the peculiarly dense and luxuriant undergrowth which characterizes the forest.

The importance of the subject is too great, however, to permit its neglect merely on account of difficulties in the way, and the student of the theory of descent will be grateful to Dr. Ludwig Plate for a careful and critical review of the literature bearing on the theory of natural selection, which has appeared during the last twenty years.

Dr. Plate's essay was first published some four years ago in the 'Verhandlungen der deutschen Zoologischen Gesellschaft' and is now republished in a somewhat enlarged form under the title given above. It is a concise yet clear exposition of the arguments that have been advanced in opposition to the theory of natural selection and of the principles which have been suggested as accessories in the transmutation of species, and with the exposition there goes keen criticism backed by a wealth of illustration, in itself of the greatest interest and evidencing in the author unusual powers of observation and aptness in application. A further chapter deals with the postulates of the doctrine of natural selection, such as an excessive birth rate, variability and isolation, and a concluding one considers the significance and limitations of the Darwinian and Lamarckian factors, especially with regard to adaptation.

That the work is of merit is abundantly shown by its appearance in a second edition

so soon after its original publication, both as a separate volume and as a contribution to the proceedings of a learned society. It is not merely an exposition of conflicting views; it is a decided contribution to the theory of descent, a perusal of which is rendered both interesting and in a high degree instructive by a notable clearness of statement and a judicious and intelligent arrangement of topics. Every student of the theory of descent will find it of great value, and an English translation, which might render it available for the wide circle of those interested in the present position of the theory of natural selection, is highly desirable.

It may with propriety be added that the book is furnished with an excellent author and subject index and contains a bibliography consisting of over two hundred and sixty references.

J. P. McM.

SCIENTIFIC JOURNALS AND ARTICLES.

THE longer articles of the September and October numbers of the *Botanical Gazette* are all ecological. They contain the first half of a long contribution to the ecological plant geography of the province of New Brunswick by Professor W. F. Ganong, of Smith College, entitled 'The Vegetation of the Bay of Fundy Salt and Diked Marshes.' The first instalment discusses the distribution and extent of the marshes (with maps); their geological origin and mode of formation; the economics of the marshes, including crops, prices and mode of reclamation; factors determining the ecological features of the marsh vegetation, including a discussion of the relations of water, temperature, light, soil and animals; and after summarizing the ecological factors the author enters upon a consideration of the vegetation of the marshland.—Mr. G. H. Shull, of the University of Chicago, gives a thorough account of 'The geographic distribution of *Isoetes saccharata*,' a plant limited to the fresh-water portions of Chesapeake Bay and its tributaries. After listing and mapping the known stations of this plant, the author discusses the causes to which its restricted distribution is due. He considers it autochthonous in Chesapeake Bay and the parent of *Isoetes riparia*, its present distribution being explained by the geomorphic movements of the coastal plain.—Mr. S. B. Parish, of San Bernardino, presents 'A Sketch of the Flora of Southern California.' After an extended statement of the orographical features of the region, the deserts, the drainage system, the geological formations and the climate, he describes the phytogeographic areas and discusses the flora peculiar to each. The interrelations of the different life areas, the physiognomic characteristics of the flora, the distribution of the plants, the statistics of classification and the affinities of the flora are successively presented. The paper closes with a comparison of the flora of southern California with that of various other regions east and west, and with a few words on the cryptogamic flora, which has yet been imperfectly explored.—In the October number Professor John W. Harshberger, of the University of Pennsylvania, presents the first part of 'An Ecological Study of the Flora of Mountainous North Carolina.' The topography, drainage, physiography and geology of the region are described, and also the effect of the physiographic changes upon the distribution of plants. After discussing the phenological distribution of plants the author takes up the influence of glaciers upon the flora of North Carolina and the principles underlying the distribution of plants in eastern America, closing this portion with a consideration of the effect of edaphic factors.—The 'Briefer Articles' are more varied. In the September number Professor Charles Thom describes a gall produced by insect larvæ upon a delicate mushroom, *Omphalia campanella*, a phenomenon which has not been previously reported.—Professor W. C. Coker, of the University of North Carolina, shows that the usual absence of dorsal air chambers in the genus *Dumortiera* is dependent upon its semi-aquatic habits, and that it has evidently been derived from forms possessing such structures. He also gives a drawing showing the origin of the branched cells ramifying in the Nostoc-chambers of *Blasia pusilla*. In the sporangium of *Sphærocarpus terrestris* he finds round sterile cells, probably the homo-

logues of elaters, containing chlorophyll bodies which remain green almost to the time of ripening of the spore. In the October number Professors G. F. Atkinson, of Cornell University, and W. C. Coker, of the University of North Carolina, describe a minute new species of *Geaster, G. leptospermus,* belonging to the fornicate section of the genus, which was found growing upon mosses on tree trunks by Professor Coker.—Professor B. M. Davis, of the University of Chicago, notes the occurrence of spores of a *Tilletia* (?) in the capsule of *Ricciocarpus natans,* and Dr. Florence M. Lyon figures a section of the sporophyll and axis of *Selaginella rupestris,* showing two megasporangia, a phenomenon not hitherto reported.—There are the usual reviews of current literature and items of news.

SOCIETIES AND ACADEMIES.

THE TORREY BOTANICAL CLUB.

At a meeting of the club held at the College of Pharmacy on October 15, 1903, Dr. Rusby occupied the chair.

The scientific program consisted of brief informal reports on the summer's work by the different members.

Dr. Britton reported having made a second trip to Cuba, leaving New York the latter part of August. He was accompanied by Mrs. Britton and Mr. Percy Wilson. In part the same ground was covered as in his first expedition, but the journey was continued into the province of Santa Clara. At Sagua a small area was encountered covered by an isolated flora somewhat similar to that found at Madruga on the first trip. Both areas were characterized by an abundance of a peculiar palm that was not seen elsewhere. The species is as yet undetermined, but living specimens have been successfully brought to the garden. Both of these peculiar plant associations are on soil areas quite different from the prevailing coral-limestone formation.

Mr. Earle reported having made a trip to Porto Rico in the interest of the Department of Agriculture during the last of May and the first of June. The trip was mostly for the purpose of noting the diseases of economic plants, and a report has been submitted to the department. One of the most interesting things observed was the occurrence of several fungous diseases of scale insects. Two of these diseases were abundant enough to constitute efficient checks on the scales attacked.

Professor Lloyd reported having spent some weeks on the island of Dominica, accompanied by Mrs. Lloyd. He observed many orchards of limes in poor condition owing to the attacks of scale insects and wood-destroying fungi. He illustrated his exploration of the island by means of a blackboard map showing the position of three volcanic craters and of the highest peak visited, 4,700 feet. A large collection of herbarium material was secured.

Professor Underwood spoke on the ferns of Jamaica. He left New York early in January, spending five months in Jamaica and eastern Cuba. Jamaica is especially rich in ferns, about five hundred species being known from the island. Of these he collected over four hundred, mostly in the Blue Mountain region from an area about equal to that of Westchester County. A hundred species may be taken along the bridle path from Cinchona to Morce's Gap, a distance of three miles. Tree ferns become abundant at an elevation of about 3,000 feet. Thirty species are more or less common. The trunks are often covered by rich growths of filmy ferns, of which about sixty species occur. The John Crow Mountains in eastern Jamaica have never been visited by botanists and the 'Cock Pit Country' in the western end of the island had not been previously visited. He spent a week, accompanied by Mr. Harris, of Hope Gardens, Jamaica, in exploring one corner of this region and found many things of interest.

Mr. Nash reported on his recent trip to Haiti. The country belongs to the negroes and a white man has to take second place. The island is 407 miles long by 195 miles wide, with extremely diversified topography. There are two main ranges of mountains. Large salt lakes occur in the southern portion. In the north-central area there are large pine forests. The strand flora is much like that of the other islands, but as you get into the interior the character entirely changes and there are

many endemic species. Tree ferns begin at 1,500 feet elevation, but they are much more abundant at 3,500 feet, the highest point reached by the expedition. There are no roads in the interior, only uncared for bridle trails, and there are absolutely no bridges. One stream was forded sixteen times in a distance of twelve miles. A thousand numbers of herbarium material were secured besides living plants and wood specimens.

Dr. Howe spoke of two months spent in Porto Rico collecting marine algæ. He found the species fairly numerous, but on the whole the marine vegetation was less striking and luxuriant than on some of the Florida keys. He visited the north, west and south sides of the island, but found less difference in their algal flora than he had expected. Nine hundred numbers were taken, but so far most of the material is unstudied.

Dr. Murrill reported on his visits to various European herbaria for the purpose of studying types of the species of the Polyporaceæ. Upsala, Berlin, Kew and Paris were visited and some time was spent in field work with Bresadola in the mountains of the Tyrol. Interesting comments were made on the different herbaria and the men who made or are now working with them.

Professor Underwood called attention to the fact that the different expeditions from the botanical garden during the past year had brought back fully 10,000 numbers of herbarium material from the West Indies.

Dr. Britton spoke of the recent death, after a long and painful illness, of Mr. Cornelius Van Brunt, who was one of the oldest members of the club. His work in the photographing of plants was unique, and he leaves a collection of over 10,000 studies on glass. He had done much in devising special lenses and appliances for this special work and his knowledge of photographic technique was remarkable. His earlier studies were with the diatoms, but failing eyesight prevented his work with the microscope and he turned to photography instead. Data are being gathered for a more extended notice of his life.

F. S. EARLE,
Secretary.

NEW YORK ACADEMY OF SCIENCES.
SECTION OF GEOLOGY AND MINERALOGY.

THE Section met in the large lecture hall of the American Museum of Natural History on Monday evening, October 19. Three hundred and fifty-two members and friends were present. The following papers had been presented by Dr. George F. Kunz for reading by title:

Bismuth (Native) and Bismite from San Bernardino County, Calif.

Californite (Vesuvianite), a New Ornamental Stones from Siskiyou County, Calif.

The meeting was devoted mainly to a paper by Dr. E. O. Hovey entitled 'Observations on the 1902–1903 Eruptions of Mt. Pelé. Martinique.' In this paper or lecture the author sketched the principal events in the volcanic history of the island during the past year and a half. He described the phenomena of the eruptions, the mud-torrents and mud-flows, the attendant and subsequent aqueous erosion on the slopes of the mountain, the rise and vicissitudes of the new cone of eruption and its wonderful spine or obelisk. The lecture was illustrated with about ninety-five lantern slides from negatives taken by the author on the two expeditions which he has made to Martinique for the American Museum of Natural History since the eruptions began.

EDMUND OTIS HOVEY,
Secretary.

DISCUSSION AND CORRESPONDENCE.

ANTEDATED PUBLICATIONS.

DURING recent years attention has been called so strongly to the evil of antedated papers published by museums and scientific societies that in general great care has been taken of late to have all brochures emanating from such sources bear the correct date of issue. It is hence all the more surprising to find one American institution of high standing still apparently careless or indifferent in the matter. We believe, however, that the impropriety about to be mentioned is due to either inadvertence or lack of appreciation of

its seriousness on the part of the responsible authorities.

During the last few months the Field Columbian Museum of Chicago has issued a number of papers, some of them describing new species and new genera, which bear date 'June, 1903,' but which were not issued till late in August or early in September. In some instances the authors' separata were not delivered to them till August 20. In one case at least there is internal evidence to show that the paper, dated 'June 1, 1903,' could not have been even printed till some time in July, since reference is made by the author to the July, 1903, number of the *American Journal of Science*, which was not published till July 1 or 2.

I am authoritatively informed that the authors are in no way responsible for the dates, or anything else, on the title pages of these brochures, and hence the responsibility for the antedating of papers which contain descriptions of new genera and species by from eight to ten weeks rests higher up. Presumably it is sufficient to call attention to the matter to have the fault promptly remedied.

J. A. Allen.

THE 27-DAY PERIOD IN AURORAS AND ITS CONNECTION WITH SUNSPOTS.

To the Editor of Science: During the last few months in New England there has been an interesting example of the tendency of auroras to return after intervals of 27 days. The report of the New England 'Climate and Crop Service' shows that auroras were observed in New England on July 25 and 27, the 26th being rainy. Twenty-seven days later auroras were observed on August 21 and 22. The next return of the twenty-seven-day period was September 17 to 19. General rain fell on September 17, but auroras were observed on the 18th and 19th. Twenty-seven days later was October 14 to 16. Auroras were observed on the 13th and possibly on subsequent dates (the reports are not yet in).

Another group of auroras began on August 26, was observed again on September 21 and was due on October 19.

Each of these auroral displays was connected with sunspot activity and may have preceded the first appearance of the spot. A fine group of sunspots crossed the surface of the sun next the earth on October 5 to 17, passing the sun's meridian about October 13. A second smaller isolated spot crossed the sun's meridian on October 18 or 19.

About November 1 a very large sunspot crossed the meridian of the sun next the earth and with it apparently began a new series of auroras which were very brilliant on the early morning of November 1 and again on the evening of the same day.

According to the theory of Arrhenius, which has much to sustain it, auroras are caused by small highly electrified particles of matter carried outward from the sun by the pressure of light when the sun is in a high state of activity. These particles are intercepted by the earth's atmosphere and from them is derived the electrical charge which gives rise to auroras and magnetic currents ('Lehrbuch der kosmischen Physik,' page 920).

The twenty-seven-day period in the aurora arises from the fact that it takes twenty-seven days for a center of disturbance on the sun to rotate around and face the earth in the same relative position again. The period is not a permanent one, the disturbance at any given point lasting usually only for a few solar rotations, and is then displaced by a disturbance at some other part of the sun with which another series of auroras is connected.

There is, however, a twenty-seven-day period of auroras connected with the siderial revolution of the moon. This, however, is of minor importance and can only be detected by a long series of averages (*American Journal of Science*, Vol. V., 1898, p. 81).

If the auroras described here were of solar origin they were probably visible over a large part of the northern and southern hemispheres. Some of them were very brilliant. The aurora of August 21 was described in the *Popular Science Monthly*, Vol. LXIII., pp. 563–564, by A. F. A. King, and in Vol. LXIV., pp. 87 and 88, by Alexander Graham Bell.

Henry Helm Clayton.

SHORTER ARTICLES.

MONT PELÉ FROM MAY TO OCTOBER, 1903.

THE changes which have taken place in the new cone of Mont Pelé within the last few months have been very considerable, and are worthy of record. The wonderful growth of the spine upon the top of the cone has been fully described by Professors Lacroix, Heilprin and Sapper and the author. The author's article in the *American Journal of Science* for October brought the detailed history of the cone down to the month of April last. There was at that time a tremendous spine or tooth more than 1,000 feet in height, rising from the side of a cone-shaped base, the top of which was higher than the old altitude of Morne Lacroix. The tip of the spine was about 600 feet above the highest part of the new cone. Since the first of May there have been considerable variations in the activity of the volcano and in the form and altitude of the cone and spine. It is the purpose of the present note to give the readers of SCIENCE a condensed statement of the facts as they have been observed by the French commissioners during the past six months and reported by Professor Giraud and Captain Perney in the *Journal Officiel de la Martinique* published at Fort de France.

During the month of May the apex of the spine rose slowly until the thirtieth, when there occurred a loss of about fifty meters. Considerable incandescence was observed at night, when the condition of the clouds permitted observations to be made, and there were several eruptions of steam to an altitude of from 3,000 to 4,500 meters. Most of the dust clouds thrown out by the mountain pursued the familiar course down the valley of the Rivière Blanche. There was marked increase in the energy of action during the last week of the month, which diminished, however, during the first week of June. During June the spine rose again with varying degrees of rapidity, until it seems to have regained much of the altitude lost at the end of May. Minor eruptions were numerous during the month, and the dust-flows, of 'Nuages Denses' of Lacroix, rushed with violence and great velocity down the valley of the Prêcheur, as well as that of the Rivière Blanche. The latter fact is of interest in connection with observations made in February and March, that the northwestern side of the new cone had become continuous in slope with the exterior of the old cone of the mountain.* The V-shaped gash in the old crater has long ceased to be the sole exit for the flows of dust-laden steam, or the principal factor in guiding their course. The records show that the western side of the spine kept losing material constantly, so that late in June and early in July it was even more pointed and blade-like than in March. Between July 5 and 7, however, there was a loss of altitude amounting to fifty meters, and another fifty meters was lost in the succeeding week. On the 18th it was observed that eighteen meters more had disappeared. This diminution continued into August, a measured loss amounting to twenty-five meters having occurred by August 6.

On August 17 Professor Giraud saw the mountain free from clouds for the first time in several days, and perceived that the *dome* of the cone surmounting the crater had undergone profound modification, the central portion having risen twenty-seven meters within ten days. Reddish-brown clouds frequently appeared in the midst of the blue and white vapors which were continually rising from the crater. During the night the dome sometimes showed itself incandescent; some of the luminous points persisted throughout the whole night, and there were frequent discharges of incandescent blocks. The increase of activity continued in marked degree for several days, and the main mass of the dome, as distinguished from the spine, continued to rise. There were numerous dust-flows down the valley of the Prêcheur and of the Blanche, and on the 22d, in the direction of the Lac des Palmistes and Grand' Rivière as well. Night after night the top and slopes of the new cone or dome were incandescent, and often sufficiently so to cast a strong illumination upon the clouds. Fumaroles were active in the valley of the Sèche, as well as in the valley of the Blanche. The growth of the great dome continued rapid, one hundred and

* *Am. Jour. Sci.*, Vol. XVI., p. 277, October, 1903.

four meters being the measured increase from August 21 to 31. The eruption of September 2 caused a loss of thirty meters, and the succeeding five days saw thirteen meters of this regained; a gain, however, which was only temporary, fifteen meters being lost upon the following day. During the remainder of the month there was an irregular increase of thirty-one meters, with a loss between the 15th and 18th of five meters. The total increase in height of the dome for the six weeks ending the first of October was about one hundred and twenty-seven meters.

The great spine which was such a wonderful part of the mountain from November, 1902, to June, 1903, had practically disappeared early in August when the main mass of the cone, or the 'dome' as it may well be called, began to rise so rapidly. The first spine rose from the northeastern quarter of the new cone. On September 8, after four days in constant cloud, the summit appeared and it was seen that the dome culminated in a sharp tooth or spine rising from its northwestern portion. Within a week this new spine was pushed up twenty meters, but an eruption on September 17 destroyed it. At the end of the month (September) the highest part of the dome was at the south.

During about six weeks in August and September the activity of the volcano was so great as to cause serious fears of the recurrence of great eruptions, and several warnings were sent out by the geological commission to the inhabitants of the northern and northeastern parts of the island of Martinique. On September 12, at 2 P.M., there was an eruption, the dust cloud of which covered the Lac des Palmistes and rapidly descended the eastern slopes of the mountain toward the village of Morne Balai to the altitude of about seven hundred meters; that is to say, it reached the limit of the zone devastated by the eruptions of May, 1902. A week later three such clouds followed one another in quick succession nearly to the same extent. On September 16 an eruption cloud rose vertically to the extraordinary altitude of 7,000 meters. During the latter part of September, however, the activity diminished again, and is recorded as being very feeble on September 30. The bulletins from October 1 to 19, the date of the latest received, indicate only feeble activity of the volcano, with occasional persistent luminosity of the dome. The seismographs which were installed in the observatory at Morne des Cadets in the fall of 1902 had recorded no earth tremor by April 1. Light earthquake shocks made their imprint on these instruments on July 23 and August 28, and others have been noted by the observers at Assier.

Edmund Otis Hovey.
American Museum of Natural History,
November 3, 1903.

*THE HUXLEY MEMORIAL LECTURE.**

The fourth annual Huxley memorial lecture of the Anthropological Institute was delivered in the lecture theater of Burlington House by Professor Karl Pearson, F.R.S. The president of the institute, Mr. H. Balfour, occupied the chair.

The lecturer's subject was 'The Inheritance in Man of Moral and Mental Characters,' a subject to which he has devoted many years of close and constant study, and the importance of which, as he observed, from a national point of view can hardly be exaggerated. It was a question of vital importance, he observed, as to how far mental and moral characters were inherited as compared with physical characters. Few denied the inheritance of physique in man, as in animals, but few too applied the results of such acceptance to their own conduct in life. We were agreed that good homes and good schools were essential to national prosperity, but were apt to overlook the possibility that the home standard was itself a product of parental stock, and that the relative gain from education depended to a surprising degree on the raw material. Since the publication of Francis Galton's epoch-making books it was impossible to deny *in toto* the inheritance of mental characters. But it was necessary to go a stage further and ask for an exact quantitative measure of the inheritance of such characters and a comparison of such measure with its value for the physical characters. Accordingly he had some six or seven years ago set

* From the London *Times*.

himself that problem, which really resolved itself into three separate investigations—namely, a sufficiently wide inquiry into the actual values of inheritance of the physical characters in man, and this was carried out by the measurement of upwards of 1,000 families; a comparison of the inheritance of the physical characters in man with that of the physical characters in other forms of life; and an inquiry into the inheritance of the mental and moral characters in man. In respect of this last set of investigations children were taken in schools of different sorts all over the country, and the opinions of teachers were asked upon the characters of their pupils in respect of the physical, mental and moral resemblances between brother and brother, sister and sister, and brother and sister. Six thousand circulars were thus sent out to about 200 schools. In respect of physical characters the data included the cephalic index—*i. e.*, ratio of the length to the breadth of the head, the span, color of eye and hair, curliness of hair, athletic power and health. In respect of all these the measure of the fraternal resemblance, indicated by the well-known regression line, was as two to one—that is to say, that if one of the pair exceeded the mean by a certain amount, the other of the pair tended to exceed the mean by half that amount; and similarly in respect of defect from the mean. This was always true for all the physical characters yet worked out in man. Now, seeing there was this surprising uniformity in the inheritance of the measurable physical characters, could these results be extended to psychical characters? Could we—that was the whole problem—get a corresponding regression line of two to one in steepness or slope in respect of mental and moral characters. A very large number of observations made on 1,918 pairs of brothers as to vivacity, assertiveness, introspection, popularity, conscientiousness, temper, probity, handwriting and general ability showed that while the line of regression was one to two or 50 to 100 in respect of physical characters, the smaller number was represented in respect of mental and moral characters by 51; while in respect of a large number of pairs of sisters it was 52, and these two numbers tended to approximate to 50 with an allowance for probable error. Hence there could be small doubt that intelligence or ability followed precisely the same laws of inheritance as general health, and both followed the same laws as cephalic index or any other physical character. There was a true line of regression in each case (.5 or 1 to 2), and it could safely be said that general health in the community was inherited in precisely the same manner as head-measurements or body-lengths. What results followed therefrom? By assuming our normal distribution for the psychical characters, there was found, in addition to self-consistent results, the same degree of resemblance between physical and psychical characters; and that sameness involved something additional—namely, a like inheritance from parents. We inherited our parents' tempers, conscientiousness, shyness and ability, even as we inherited their stature, forearm and span. Again, within broad lines, physical characters were inherited at the same rate in man and the lower forms of life. The irresistible conclusion was that if man's physical characters were inherited even as those of the horse, the greyhound or the water-flea, what reason was there for demanding a special evolution for man's mental and moral side? If the relation of the psychical characters to the physical characters was established, what was its lesson? Simply that geniality and probity and ability might be fostered by home environment and by provision of good schools and well-equipped institutions for research, but that their origin, like health and muscle, was deeper down than those things. They were bred and not created. It was the stock itself that made its home environment, and the education was of small service unless it were applied to an intelligent race of men. Our traders had declared that we were no match for Germans and Americans. There did seem to be a want of intelligence to-day in the British merchant, workman or professional man. The remedy was not in adopting foreign methods of instruction or in the spread of technical education. The reason of the result was that the mentally better stock in the

nation was not reproducing itself at the same rate as of old; the less able and the less energetic were more fertile than the better stocks. No scheme of wider or more thorough education would bring up in the scale of intelligence hereditary weakness to the level of hereditary strength. The only remedy, if one were possible at all, was to alter the relative fertility of the good and bad stocks in the community. Grave changes had taken place in relative fertility during the last forty years. He ventured to think that we now stood at the beginning of an epoch that would be marked by a great dearth of ability. We had failed to realize that the psychical characters—the backbone of a state in the modern struggle of nations—were not manufactured by home and school and college; they were bred in the bone, and for the last forty years the intellectual classes of the nation, enervated by wealth or by love of pleasure, or by following an erroneous standard of life, had ceased to give us in due proportion the men wanted to carry on the ever-growing work of our empire, to battle in the fore rank of the ever-intensified struggle of nations. The remedy lay first in getting the intellectual section of our nation to realize that intelligence could be aided and be trained, but that no training or education could create it. It must be bred; that was the broad result flowing from the equality in inheritance of the psychical and the physical characters in man, and that result constituted a problem for statecraft to deal with.

SCIENTIFIC NOTES AND NEWS.

President Schurman, of Cornell University, has proposed the erection of a new building for Sibley College, in memory of the late Professor Thurston, to be known as Thurston Hall. The students of Sibley College have voted to erect a bronze memorial tablet in honor of Professor Thurston.

Dr. C. S. Sherrington, professor of physiology at Liverpool University, will give the second series of Silliman lectures at Yale University.

Professor H. S. Jacoby, of Cornell University, is spending the present term in the practical study of the bridges of the chief railroads of the United States and Canada.

Professor J. Culver Hartzell, of the Illinois Wesleyan University, is in Munich, having been given leave of absence for eighteen months. He is studying the upper devonian of Europe. The past seven months he has spent in Germany, and the next five months will be spent in Italy and Switzerland.

We learn from Bulletin No. 4 of the Bureau of Agriculture of the Philippine Islands that Dr. Janet Perkins has been authorized by the Carnegie Institution to work on the Philippine flora at the Botanical Garden in Berlin.

Dr. Llewellys F. Barker, professor of anatomy in the University of Chicago, sailed for Europe on November 7.

Professor E. W. Scripture, of Yale University, is in Munich carrying on researches on the analysis of speech by means of gramophone records, under the auspices of the Carnegie Institution.

Professor H. S. Hele-Shaw, who holds the chair of engineering at Liverpool University, has been appointed, through the Colonial Office, to organize technical education in the Transvaal and the Orange River Colony. The appointment is not a permanent one, and Professor Hele-Shaw has been granted leave of absence by the university council until September next.

The committee of the National Physical Laboratory has appointed Mr. W. A. Caspari to the post of junior assistant in the chemical department.

We learn from *Nature* that Mr. G. Marconi, in company with Captain H. B. Jackson, has gone to Gibraltar to carry out further experiments in wireless telegraphy for the Admiralty. It is hoped to be able to open communication with Gibraltar before losing touch with Portsmouth.

Baron E. Nordenskiold has arranged to make a zoological and anthropological expedition to the frontiers of Peru and Bolivia. The expedition will start from Stockholm at the end of December or the beginning of January.

While students of the Agricultural College

at the Ohio State University were witnessing on November 6 the harvesting of a field of corn for ensilage purposes by a machine operated by an old traction engine, the boiler exploded and pieces of iron were thrown through the crowd of students. The engineer was killed, and Vernon H. Davis, assistant professor of horticulture, was injured.

WE learn from *Nature* that the bust of John Dalton, presented to the Manchester Literary and Philosophical Society by Sir Henry E. Roscoe on the occasion of the centenary of the announcement of the atomic theory, was unveiled on October 20. The secretary read the following letter from Sir Henry Roscoe: "I desire to present to the Literary and Philosophical Society of Manchester a bronze bust of Dr. Dalton, as a memento of the many years of pleasant intercourse which I have in past days spent in converse with its members, and as a recognition of the honor which the society has done me by electing me as an honorary member, and in bestowing upon me its Dalton Medal. The bust is the work of a distinguished sculptress, Miss Levick, and I believe that all those who have seen it agree with me in esteeming it a powerful and lifelike work of art. It will give me great satisfaction to hear that the society accept my gift, and that they value the bust as a work of art and as a reminiscence of the donor." The president, in formally unveiling the bust, observed that it was a happy coincidence that this meeting took place on the anniversary of the date when Dalton communicated to the society his paper on absorption of gases by water, in which was given the first hint of the atomic theory.

DR. FRANK RUSSELL, one of the most promising of the younger American anthropologists, recently of Harvard University, died of tuberculosis in Arizona on November 7.

THE death is announced of Dr. C. T. Hudson, F.R.S., known for his investigations on the rotifers.

AT a meeting of the Kalamazoo Academy of Medicine held on November 3, Dr. F. G. Novy presented the results of work carried on, with the cooperation of Mr. McNeal, in the Hygienic Laboratory of the University of Michigan relative to the cultivation of the trypanosome of Nagana or the Tsetse-fly disease of South Africa. They have succeeded in cultivating this flagellata, *in vitro*, for the past two months (68 days), through six generations. The fresh active cultures reproduce the disease in animals, modified cultures are without virulence and may possibly serve as vaccines. The method of cultivation is the same as that employed for the cultivation of rat trypanosomes, published in the Vaughan *Festschrift*. The rat and Nagana trypanosomes are the first pathogenic protozoa cultivated in pure condition outside of the body.

IT appears that Rear-Admiral R. B. Bradford, chief of the Bureau of Equipment of the Navy Department, in his annual report to Secretary Moody, says that the commission appointed to consider the question of transferring to the Department of Commerce and Labor the hydrographic office, the naval observatory and the nautical almanac office, has reached the conclusion that it would be unwise to transfer these offices from the jurisdiction of the Navy Department on account of their nautical character and their indispensable aid in preparing for war. The bureau says it learns that it is proposed to place these offices under civilian control, and attach them to the secretary's office.

THE new observatory of Amherst College, the corner stone of which was laid on June 23 last, has so far advanced toward completion that the first series of regular observations was begun by Professor Todd and his assistant, Mr. Baker, on October 28. The sum of $100,000 has been raised for endowment, observatory building, protection of the site, instrumental equipment and the director's residence.

As we stated last week, the Academy of Natural Sciences of Philadelphia has received from Dr. Thomas Biddle a collection of anthropoid apes. It consists of mounted skins and skeletons of the gorilla, two adult specimens of the bald chimpanzee, young male of the common chimpanzee and an aged male orang. All were mounted by Umlauff of Hamburg. The gorilla is an adult male in perfect condition, and in life must have weighed at least three hundred and twenty-five pounds. At the regular meeting of the

academy on November 3, the collection was formally presented by Dr. H. C. Chapman and Mr. A. E. Brown, before the largest audience ever gathered in its lecture hall.

English papers state that Mr. F. du Cane Godman has recently presented to the British Museum (of which he is a trustee) a collection of nearly 30,000 specimens of beetles, following on a previous donation of 50,000. The present collection consists mainly of representatives of the family Elateridæ, the bulk being from Central America.

The fourteenth International Congress of Americanists will be held at Stuttgart from August 18 to 23, 1904, under the presidency of Professor Karl von den Steinen. The general secretary is Professor K. Lampert, Stuttgart, Archivstrasse 3.

A cablegram to the daily papers states that the *Terra Nova* arrived at Hobart, Tasmania, on October 1. The *Morning,* the relief ship of the Royal Geographical Society, is expected daily. The two vessels will start to the relief of the *Discovery* during the first week in December.

The Linnean Society of New South Wales has acquired the compass and sun dial used by Charles Darwin on the voyage in the *Beagle.*

The daily papers say that a meteorite, weighing from ten to twenty tons, has been discovered near Oregon City, Ore.

At recent sales in London a complete set of *Curtis's Botanical Magazine* from 1787 sold for £120; a copy of 'The Herball, or Generall Historie of Plantes,' 1597, for £15 15s., and 'De Arte Supputandi,' printed by R. Pynson, 1522, the first treatise in arithmetic published in England, for £20.

Nature states that the zebra stallion Matopo, which has been described and figured by Professor Cossar Ewart in his book 'The Penycuik Experiments,' and was the sire of some interesting zebra-horse hybrids, is dead. This zebra was purchased some time ago by Mr. Assheton-Smith, Vaynol Park, Bangor, who was hopeful that he might find it possible to repeat some of Professor Ewart's experiments, but unfortunately his expectations have not been realized. Whilst retaining the skin, he has presented the skeleton of the zebra to the University College of North Wales, where it will form a handsome addition to the zoological collection. It may also be noted that to this college Professor W. A. Herdman, F.R.S., of Liverpool, recently made a donation of some fishes from Ceylon and Indo-Malaya which he collected when in the east investigating the pearl fisheries of Ceylon. Professor D'Arcy Thompson, C.B., Dundee, has also presented a skeleton of the somewhat rare sea otter (Enhydra) from Alaska.

Word has come to the office of the United States Geological Survey that Mr. L. M. Prindle has completed the reconnaissance survey of the Forty-mile gold placers and also of the Seventy-mile placer fields in Alaska. He is now investigating the auriferous placers of the Birch Creek district, where he was joined by Mr. Alfred H. Brooks. Together they will make a hasty examination of the newly discovered gold fields on the lower Tanana River. Mr. Brooks spent a few days in the Juneau district with Dr. Arthur C. Spencer and Mr. Charles W. Wright. The areal mapping of the Juneau Special quadrangle has been completed, and the study of the ore bodies has been begun. Dr. Spencer will make a hasty examination of the important gold mines at Seward and Berner's Bay, on the east coast of the Lynn Canal, in the latter part of the season. Mr. Wright, before joining Dr. Spencer, spent about three weeks in the Porcupine placer district, which lies above the head of the Lynn Canal, near the International Boundary. His results, which included a study of the economic conditions, will be prepared for publication in the early part of the winter. Dr. George C. Martin spent the month of June in the Controller Bay oil fields, and in August visited the Cook Inlet oil fields. Mr. Brooks, who has charge of the Alaskan work, will return to Washington about the end of October, after visiting the two parties engaged in mapping the placers of the Nome region.

Major Powell-Cotton, of the British Army, has, according to Reuter's Agency, just completed a journey in Eastern Equatorial Africa

lasting 20 months. The expedition has resulted in some thousands of miles of hitherto unknown country being mapped, and in the discovery of six new tribes, including a race of so-called magicians. Data have also been collected regarding the cave dwellers of Mount Elgon. Fifty different species of animals have been secured, some of which will probably prove to be new to science. The explorer also succeeded in bringing back some perfect specimens of five-horned giraffes. For several months the expedition was traversing a region between the Upper Nile, Lake Rudolf and Lake Victoria in which no white men had previously set foot. Of the so-called magicians, whom Major Powell-Cotton came upon half way between Lake Rudolf and Lake Albert, and who in their appearance and their customs are quite distinct from any other tribe, he gives the following account: "Their villages were remarkable. Built of wattle and grouped together in dozens on the upper slopes of the hills, these dwellings were constructed with two storeys, the upper floor being approached through a dormer window, reached from the ground by means of a rude ladder. At no other point have I seen native houses consisting of two floors. These people, living in the higher altitudes, are able to grow corn, while the warlike natives in the plains below are scorched by drought, and yet in such awe are the magicians held that the starving people below, who outnumber the hill villagers by perhaps a thousand to one, have never been known to attack them. These people had never before seen a white man, and during the several days I spent in their country they were quite friendly and supplied us with food."

A BULLETIN from the Bureau of Forestry states that the Territorial Government of the Hawaiian Islands will appoint as superintendent of forestry this winter a man furnished it by the Bureau of Forestry, who will take charge of important projects for the betterment of the islands' forests. The man appointed will have the responsibilities first of determining the location and the boundaries of a system of forest reserves, and later of superintending a great deal of forest planting both on public and private lands. The forest conditions of the islands are unlike any that prevail in this country. Mr. William L. Hall of the Bureau of Forestry, who has just returned from a two months' examination of the islands, reports peculiar and interesting problems which forestry must solve there. The islands contain scarcely any forests capable of yielding timber of value for lumber. Nearly all the lumber used for building purposes comes from the Pacific Coast. But there are several hundred thousand acres of forest land of the greatest value for protective purposes. Indeed, so great is the importance of these forests that on their preservation depends the existence of the sugar industry, and that is equivalent to saying the continued prosperity of the islands. The sugar exports of the last fiscal year amounted to $25,000,000, and sugar is practically the only export. The raising of sugar requires an enormous amount of water, nearly all of which must be supplied by irrigation, the water being carried in flumes and ditches from the wet, mountainous parts of the islands to the dry plains on which the sugar cane is grown. The rainfall of the islands is nearly all confined to the northeast and east mountain slopes, where it is tremendously heavy, some years more than 200 inches. On the other side of the divide, and in the plains beyond, where the sugar cane grows, there may be no more than 15 inches of rain a year. The forests are largely confined to the rainy side of the mountains, and are necessary as a protective cover, to keep the ground from washing from the slopes and the rain from rushing back too rapidly into the sea. The presence of the forest cover, since it makes the stream flow regular, preventing both floods and periods of low stream flow, is indispensable to the success of irrigating projects. The value of this forest, strangely enough, consists not so much in the trees it contains —for they are frequently low, crooked, and sparsely scattered—as in the impenetrable mass of undergrowth beneath them. This undergrowth, composed of vines, ferns and mosses, is of so dense a character that it shades the ground absolutely and holds water like a sponge. It is, however, exceedingly delicate and easily destroyed. Let cattle into

such a forest and they will speedily eat or trample down the undergrowth till the bare ground is exposed. The soil then rapidly dries out and becomes hard, and the trees soon die. Grasses, insects and wind usually hasten the destruction. Cattle and goats have ravaged the Hawaiian forests without hindrance for many years and have worked further each year into the heart of the dense tropical growth. The Hawaiian public lands consist of 1,772,640 acres. All of these lands, which are in forest, and many forest areas privately owned which the government can gain possession of by exchange, will be put into forest reserves, cleared of cattle and goats, fenced and preserved.

Bradstreet's says editorially: The enormous losses already suffered in Texas and the immense power for evil, not only to that state but to the entire south, contained in the onward march of the so-called Mexican boll weevil, lends interest to the fact that a convention has been called to meet in Dallas, November 5, to consider ways and means of checking its ravages. Invitations have been sent out to all parts of the United States interested in this problem, and especially throughout the cotton producing states of the south, not only to those handling cotton itself but to all principal dealers in kindred lines. Fully one thousand delegates are expected to assemble to consider the subject. The question is getting to be a serious problem, not only with Texas producers but the entire cotton producing section of the United States, and those interested regard it as a question that should be studied and considered by every section of the United States. Under the caption 'The Cotton Weevil, a National Danger,' *Bradstreet's* some six months ago advocated a careful consideration of this subject by Congress, and the beginnings of systematic work were laid in an appropriation by Congress of a sum of money to be used in studying the pest and, if possible, finding something to check its progress. We know of no single subject that contains more of importance to the entire country's economic interests than the devising of measures to arrest and, if possible, eradicate this scourge to the principal agricultural interest of the south.

UNIVERSITY AND EDUCATIONAL NEWS.

The College for Women of the Western Reserve University has received from various donors $50,000 for the enlargement of the campus.

At the last meeting of the trustees of Columbia University, gifts amounting to $40,500 were acknowledged toward the fund for the purchase of South Field.

The board of directors of the College of Physicians and Surgeons of Philadelphia has instructed President H. C. Wood to appoint a committee to obtain plans for the proposed new library hall, on Twenty-second street, above Chestnut. The site was purchased some time ago, at a cost of $80,000. The college now has on hand a surplus of $24,000 toward the construction of the hall. Mr. Andrew Carnegie gave $50,000 for that purpose, and $54,000 was raised by the college.

The University of Wisconsin is planning to celebrate next June, with a week's exercises, the fiftieth anniversary of the first commencement.

William F. Durand, professor of Marine Engineering, has been appointed acting director of Sibley College, Cornell University, in place of the late Professor Thurston.

The following appointments have been made in the College of Physicians and Surgeons, Columbia University: Dr. Samuel W. Lambert, professor of applied therapeutics; Dr. Joseph A. Blake, professor of surgery; Dr. George E. Brewer, professor of clinical surgery; Dr. John S. Thacher, professor of clinical medicine; Dr. Frederick Peterson, clinical professor of psychiatry.

At the Illinois Wesleyan University, Dr. J. K. P. Hawks has been appointed instructor in bacteriology, Dr. J. Whitefield Smith, instructor in biology, and Mr. Bartgis McGlone, instructor in botany.

Earl Spencer has accepted the presidency of the Council of the Royal Agricultural College, Cirencester, in the room of the late Duke of Richmond and Gordon.